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Table 1: Matrix of Carbon Black Properties Imparted as a Result of Thermal Modification and Their Effect on Various Applications

Property		Wire & Cable	Food Contact	Moisture Cured Systems	Battery		Other Energy Systems
					Dry Cell	Alkaline	
Moisture Pickup (MPU) Reduction		+ve		+ve			
Poly Aromatic Hydrocarbons (PAH) Reduction			+ve				
Oxidation Resistance		+ve			+ve	+ve	+ve
Increased Graphitic Order	Electrical Conductivity/Volume Resistivity	+ve			+ve	+ve	+ve
	Thermal Conductivity						+ve
Sulfur Reduction		+ve			+ve	+ve	+ve
Reduced Volatile Metals		+ve		+ve	+ve	+ve	+ve
Improved Melt Flow		+ve		+ve			
Resiliency					+ve		
Electrolyte Absorption					+ve	+ve	+ve

TABLE 2: Moisture pick-up data for As-is and Heat-Treated Carbon Blacks

Sample	1 hr moisture pick-up (%)	Equilibrium moisture pick-up (%)
Medium Thermal Black	0.18	0.31
Heat-Treated Medium Thermal Black	0.02	0.04
CDX-975U	2.41	3.38
Heat-Treated CDX-975U	0.17	0.27
N220	1.48	2.72
Heat-Treated N220	0.08	0.24
N330	0.60	1.98
Heat-Treated N330	0.02	0.13

Table 3: Metal Impurities, Ash and Sulfur Content of As-Is and Heat-Treated Carbon Blacks

	N220	HT N220	N330	HT N330
Ash (%)	0.48	0.09	0.30	0.06
Al (ppm)	20	9	48	55
Fe (ppm)	65	15	72	33
K (ppm)	162	26	52	21
Si (ppm)	21	2	87	2
Na (ppm)	695	31	607	65
S (%)	1.02	0.10	1.23	0.13

Table 4: Colloidal Properties

	CDX-975U	Heat-Treated CDX-975U	Acetylene Black
Iodine (mg/g) ASTM D1510	250.9	90.8	86.3
NSA (m^2/g) ASTM D4820	227	71.9	73.1
DBPA (ml/100g) ASTM D2414	173	165	207
Sulfur (%) ASTM D1619	0.45	0.01	0.01
pH ASTM D1512	6.5	10.6	9.2
Moisture	0.7	0.0	0.0

Table 5: Structure Stability of Very High Structure (VHS) Blacks

Property	Method	Unit	Acetylene Black	Heat-Treated CDX-975U	CDX-975U
Oil Absorption Number	ASTM D2414	ml/100g	189.1	159.1	177.9
COAN	ASTM D3493				
1st Compression		ml/100g	152.5	151.8	157
2nd Compression		ml/100g	132.8	142.7	144.6
3rd Compression		ml/100g	123.2	136.3	137
4th Compression		ml/100g	114.5	130.3	130.3

Table 6: Moisture pick-up (MPU) and Melt Flow Properties @ 30% Loading in 10MI LDPE

	CDX-975U	Heat-Treated CDX-975U	Acetylene Black
MPU 1-hour Carbon Black(%)	1.75	0.17	0.15
MPU Equilibrium Carbon Black (%)	3.02	0.27	0.31
MPU Equilibrium Masterbatch	0.1	0.01	0.03
Melt Flow Index (g/10 min)	6.6	7.0	6.8

Table 7: Volume Resistivity Versus Processability in Polyethylene

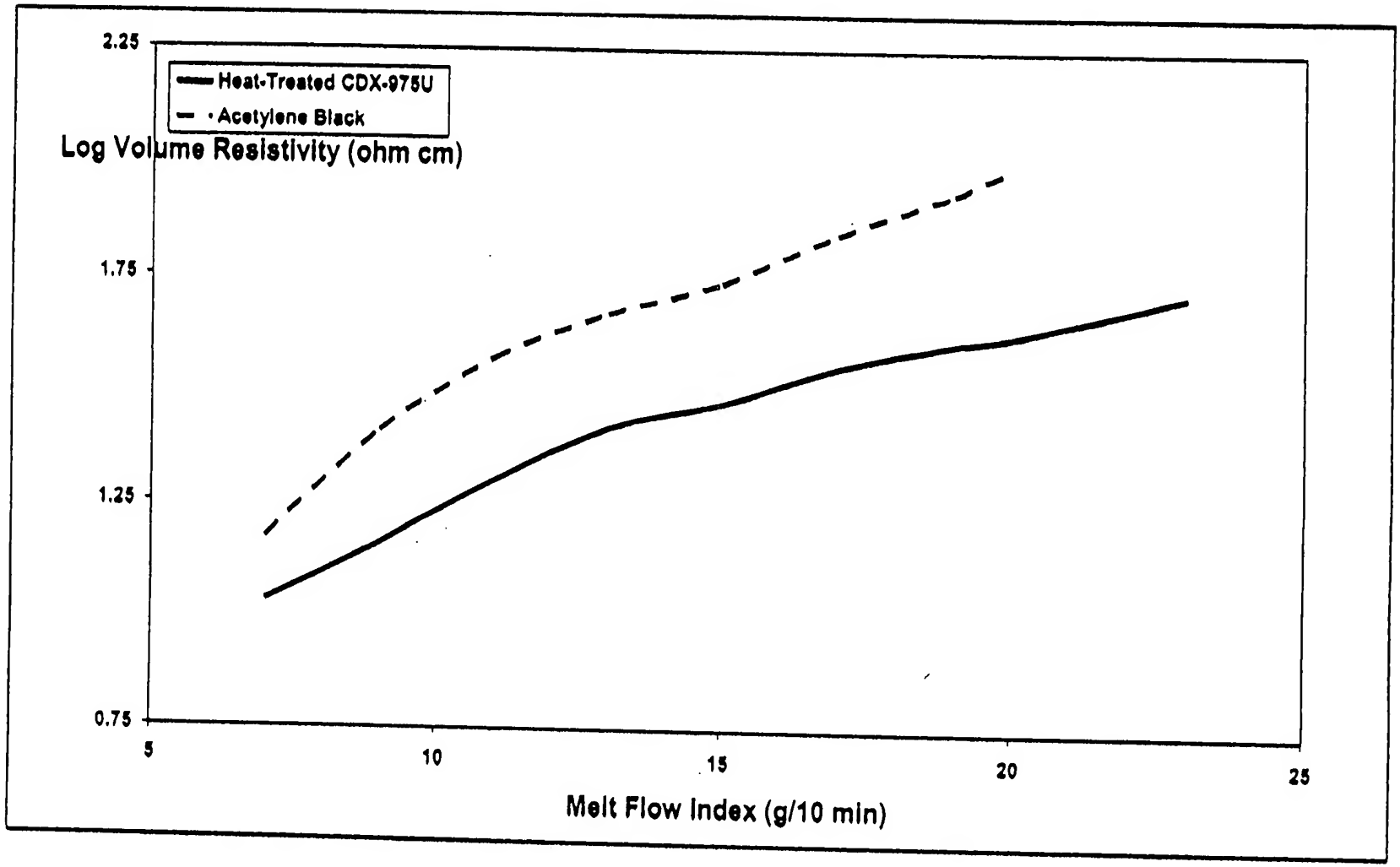

Table 8: Combustion rate and Activation Energy of CDX-975U – Before and After Heat-Treatment

Temperature., °C	Heat-Treated CDX-975U (%/min)		CDX975U (%/min)	
	In Air	In Oxygen	In Air	In Oxygen
450	0.000008	0.00008	0.00654	0.03237
500	0.00034	0.0016	0.05988	0.2201
550	0.00213	0.01950	0.3198	1.245
600	0.05144	0.32100	1.260	17.81
650	0.36530	1.5670	3.466	28.24
	Activation Energy (kcal/mole)		Activation Energy (kcal/mole)	
	73.2	70.7	40.8	43.8

Table 9: PAH Compounds Regulated by FDA

Group	PAH Compounds	Molecular Weight	Boiling Point (°C)
1	Naphthalene	128.2	218
2	Acenaphthylene	152.2	280
	Acenaphthene	154.2	279
3	Fluorene	166.2	295
4	Phenanthrene	178.2	342
	Anthracene	178.2	342
5	Fluoranthene	202.3	393
	Pyrene	202.3	393
6	Benzo(g,h,I) fluoranthene	226.3	
	Benz(a) anthracene	228.3	400
	Cyclo penta (c,d) pyrene	226	
	Chrysene	228.3	448
7	Benzo (b) fluoranthene	252.3	481
	Benzo (k) fluoranthene	252.3	480
	Benzo (e) pyrene	252.3	493
	Benzo (a) pyrene	252.3	496
	Perylene	252.3	497
8	Indeno (1,2,3,cd) pyrene	276.3	536
	Dibenz (a,h) anthracene	278.4	524

	1, 12 benz perylene	276.3	542
	Anthanthrene	276.3	525
9	Coronene	300.4	525

Table 10: PAH Content (ppb) of FDA Compliant Competitive Carbon Black, Heat-Treated CDX-975, Heat-Treated N700 Series Carbon Black and Control N700 Series Carbon Black

	FDA Compliant Competitive Carbon Black	Heat Treated CDX-975U Carbon Black	Heat Treated N700 Series Carbon Black	N700 Series Carbon Black
Naphthalene	137	12	43	2,761
Acenaphthylene	< 1	< 1	8	3,499
Acenaphthene	1	< 1	2	5
Fluorene	< 1	< 1	< 1	62
Phenanthrene	7	4	6	6,065
Anthracene	1	1	2	649
Fluoranthene	8	2	14	12,251
Pyrene	40	3	50	71,282
Cyclopenta pyrene	< 1	< 1	< 1	901
Benzo (ghi) fluoranthene	< 1	< 1	< 1	< 1
Benz (a) anthracene	< 1	< 1	< 1	705
Chrysene	4	< 1	< 1	235
Benzo(b) fluoranthene	< 1	< 1	< 1	990
Benzo (k) fluoranthene	< 1	< 1	< 1	< 1
Benzo (e) pyrene	< 1	< 1	2	3,912
Benzo (a) pyrene	< 1	2	2	4,878
Perylene	7	< 1	8	830
Indeno (1,2,3,cd) pyrene	< 1	< 1	3	5,585
Di benz(a,h) anthracene	7	< 1	5	< 1
1, 12 Benz perylene	< 1	< 1	< 1	< 1
Anthanthrene	< 1	< 1	< 1	827
Coronene	70	21	60	69,304
Total PAH, ppb	**280**	**44**	**205**	**184,741**

Table 11: PAH (ppb) content of As-Is N220, N330, Heat-Treated N220 and Heat-Treated N330

	N220	N330	Heat-Treated N220	Heat-Treated N330
Naphthalene	201	189	153	24
Acenaphthylene	614	764	24	<1
Acenaphthene	<1	<1	8.6	<1
Fluorene	<1	<1	1.5	1.8
Phenanthrene	3099	476	15	5.1
Anthracene	<1	400	17.8	<1
Fluoranthene	870	1559	20	4.9
Pyrene	1744	16490	85	32
Cyclopenta pyrene	<1	286	<1	2.6
Benzo (ghi) fluoranthene				
Benz (a) anthracene	<1	<1	<1	<1
Chrysene	4075	<1	1.1	<1
Benzo(b) fluoranthene	<1	<1	<1	<1
Benzo (k) fluoranthene	<1	106	<1	<1
Benzo (e) pyrene	<1	223	7.7	<1
Benzo (a) pyrene	<1	94	<1	<1
Perylene	<1	<1	<1	<1
Indeno (1,2,3,cd) pyrene	<1	190	<1	<1
Di benz(a,h) anthracene	13306	<1	<1	<1
1, 12 Benz perylene	3963	3422	<1	<1
Anthanthrene	<1	<1	<1	<1
Coronene	7426	10516	1.1	<1
Total PAH, ppb	**35310**	**34723**	**344.8**	**85.4**

Table 12: Summary of Maximum Discharge Capacity of as is and Heat-treated Carbon Black Samples at Three Discharge Rates

Sample	Cathode Mixture	Cathode Capacity mAh		
		Discharge Current 100 mA	Discharge Current 50 mA	Discharge Current 25 mA
Commercial Sample	Unknown	745	905	
Carbon Black A (NSA 77 m^2g^{-1}) (OAN 174 ml/100 g)	MnO_2 : 87.5% Carbon Black : 10.5% Graphite : 2%	340	600	919
Carbon Black B (NSA 173 m^2g^{-1}) (OAN 192 ml/100 g)	MnO_2 : 87.5% Carbon Black : 10.5% Graphite : 2%	486	840	997
Carbon Black C (NSA 62 m^2g^{-1}) (OAN 185 ml/100 g)	MnO_2 : 87.5% Carbon Black : 10.5% Graphite : 2%	535	786	919
A-20961 Acetylene Black	MnO_2 : 87.5% Carbon Black : 10.5% Graphite : 2%	679	812	979
HT Carbon Black B (NSA 109 m^2g^{-1}) (OAN 199 ml/100 g)	MnO_2 : 87.5% Carbon Black : 10.5% Graphite : 2%	641	886	939
HT Carbon Black A (NSA 72 m^2g^{-1}) (OAN 182 ml/100 g)	MnO_2 : 87.5% Carbon Black : 10.5% Graphite : 2%	626	750	901
HT Carbon Black C (NSA 54 m^2g^{-1}) (OAN 171 ml/100 g)	MnO_2 : 87.5% Carbon Black : 10.5% Graphite : 2%	636	780	915

Table 13

Colloidal Properties

	Method	Acetylene	A	B	N-330
OAN, ml/100g	D2414	179	159	177	101
COAN, ml/100g	D3493	115	130	---	86
Iodine No., mg/g	D1510	96	91	70	80
NSA, m^2/g	D6556	67	69	52	77
STSA, m^2/g	D6556	67	69	52	77

Table 14

Curing Bladder Formulations

PHR	Acetylene/ N330	A N330	B N330
Acetylene	48	--	--
A	--	54	--
B	--	--	60
N-330	12	12	12

Base Formula

Butyl 301	95
Neoprene W	5
Carbon Black	See Above
Castor Oil	6
Zinc Oxide	5
Stearic Acid	2
SP-1045	8

Table 15

Processing Characteristics

ASTM D1646 @ 160°C	Acetylene N330	A N330	B N330
Mooney Viscosity			
MU	61	72	72
Garlock Flow Comparator @ 200°C and 20psi			
Inches	3.0	2.8	2.5

Table 16

Capillary Rheometer Processability Characteristics
ASTM D5099, 115°C, 20L/D, 60°Entrance Angle

	Acetylene N330	A N330	B N330
Shear Viscosity, Pa-sec			
20, sec^{-1}	15840	17190	18090
100, sec^{-1}	4360	4740	5160
500, sec^{-1}	1460	1780	2000
2000, sec^{-1}	610	750	900
2000, sec^{-1}	37	43	31

Table 17

MDR Curing Profiles
ASTM D2084, 145°C, 0.5°arc, 30'Motor

	Acetylene N330	A N330	B N330
ML, dNm	3.5	4.3	4.6
MH, dNm	9.0	10.2	11.6
MH-ML, dNm	5.5	6.0	7.0
Ts1, minutes	2.0	2.0	1.6
T50, minutes	4.7	4.7	4.9
T90, minutes	10.1	11.1	12.7

Table 18

Surface Analyzer Dispersion Properties

D2663	Acetylene N330	A N330	B N330
Index	99.7	99.8	99.5
F, p/cm	5	5	8
H, μm	5	4	4

Table 19

Stress-Strain, Aged and Unaged, Properties

ASTM D412 D573	Acetylene N330	A N330	B N330
Unaged			
100% M, MPa	1.7	1.4	1.7
200% M, MPa	3.0	2.0	2.4
300% M, MPa	4.6	2.9	3.4
Tensile, MPa	9.7	9.6	9.8
Elongation, %	808	865	849

Table 20

Performance Properties

	Acetylene N330	A N330	B N330
Thermal Conductivity, D518			
W/m-K	0.299	0.388	0.377
Fatigue Life, D4482, kilocycles			
Characteristic	571	1068	595
10%	406	684	361
Compression Set, *24hr @ 150°C*, D395			
% Set	74	77	78
Tear Die C, D624			
kN/m	41	38	40
DIN Abrasion, DIN53516			
mm^3 Loss	231	238	220